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GLAUCOMA:

BY

HENRY D. NOYES, M. D.

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READ BEFORE THE

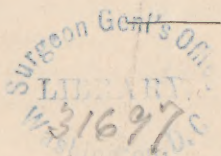
NEW YORK STATE MEDICAL SOCIETY,

AT THE ANNUAL SESSION, FEBRUARY, 1869.

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OF NEW YORK.

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ARTICLE V.

GLAUCOMA — By HENRY D. NOYES, M. D., Professor of Ophthalmology in Bellevue Hospital Medical College, Surgeon to New York Eye and Ear Infirmary.

I beg leave to call your attention to the subject of glaucoma, a disease of the eye long ago recognized, and whose designation is derived from one symptom, namely, the discoloration of the pupil which occurs in extreme cases. In former days, the disease was not recognized until this ultimate period had set in, a stage in which the malady is as much beyond our control at the present time as it was to our predecessors. My reason for bringing the subject forward is, to set forth the fact, that the disease is capable of recognition at a very early period, that the means of diagnosis fall, to a great extent, within the capacity of every physician, and that in its early stages it may be arrested.

While the name "glaucoma" is retained in modern nosology, the meaning attached to it is totally different from what it was. The central idea of glaucoma is no longer a greenish discoloration of the pupil, but is a state of *excessive tension of the eye-ball*, accompanied by a peculiar kind of excavation of the optic nerve. Out of these elements are evolved a complex series of symptoms and several pretty well defined types of the disease.

Increase of intra-ocular pressure is the clue to the phenomena of glaucoma, and the explorer, who, by a happy stroke of genius, first seized this thread, was Prof. Graefe, of Berlin; and, after the clue had revealed the mystery of the symptoms, it was not long before he found the key to its treatment.

But, at the first, there was some misapprehension of the various phases which the disease assumes. Prof. Graefe supposed that, in all cases, the disease was to be regarded as an inflammation — a kind of cloroiditis, chronic, subacute, or acute. A sharper criticism and greater experience before long corrected this view. The first to give utterance to the statements which express the nosological types of glaucoma, as now generally accepted, was Prof. Donders, of Utrecht.

The modification in Graefe's nosology, which Donders set forth, is of great practical importance, and furnishes the motive which has impelled me to bring this topic to your consideration.

It is in the highest degree needful to be known and remembered by the medical profession, that glaucoma often begins and sometimes pur-

sues its course to a fatal goal, without any evidences of inflammation of the eye.

Divisions of Glaucoma.—The disease was divided by Donders into glaucoma simplex and glaucoma cum ophthalmia,—the inflammatory action being acute, subacute, or chronic.

Symptoms.—First, the symptoms of glaucoma simplex. The subjects are usually in the latter half of life, that is, beyond forty, and of the female sex. It is very common for them to have had chronic rheumatism or gout, and to show atheroma of the arteries.

The earliest sign of trouble is rapid development of presbyopia, and occasional obscurations of vision. They see rainbow hues about a candle, and, after a time, all objects become misty. This state of things may continue for months, and the eye show no external evidence of mischief; the pupil may be sluggish, but continues contractile. One eye alone is at first affected, and when the patient asks advice, it may be because he has accidentally discovered one eye to be nearly blind. When the disease has fairly seated itself, the following signs will betray its true character: first, the eye-ball, when gently touched with the finger, will feel hard. The second sign is, contraction of the visual field. For example, when looking straight ahead, with one eye closed, the patient can count fingers on the outer, upper and lower sides of the field; but on the inner side his sight fails. A careful scrutiny shows that this limitation is not because of the projection of the nose, but is a pathological narrowing of the field. In cases of very protracted, simple glaucoma, the limitation of the field may not be chiefly on the nasal side, but may be quite uniform all around (Wecker). With the impairment of the field is associated a deficiency in direct vision, when measured by suitable tests, viz., Snellen's type.

All of these signs may be appreciated by any observant medical man and give strong ground for suspicion of incipient glaucoma. The picture becomes complete when, by the ophthalmoscope, is to be discerned, excavation of the optic nerve and spontaneous or easily excited pulsation of the retinal vessels. On the intra-ocular symptoms I will not dwell at present. Without them a very probable case can be made out—a type of disease in which the hardness of the globe would suffice to give a hint of the nature of the process, and save the patient from condemnation to one limbo of the unknown and incurable, viz. amaurosis.

Tension of the eye.—This symptom of tension has so great importance in ophthalmology that many efforts have been made to give us exact measurements of its amount. Instruments called tonometers have been made to give the amount of the elasticity of the eye on

external pressure, and other instruments called manometers have been constructed to show the pressure excited by the intra-ocular fluids. The former are complicated and inexact; the latter are not applicable to the living human eye because they require a tube to be introduced into its interior. The latter have been brought to high perfection and have been successfully applied to the eye of animals in physiological experiments. We are left to the sense of touch, the *tactus eruditus*, in our judgment of the tension of the globe. The amount of resistance offered is evidently dependent, as Stellwag says, upon two elements, the quantity of fluid within the globe and the rigidity of the sclera. Both factors probably enter into the problem of glaucoma. The normal eye gives way to gentle pressure with the finger but promptly reacts as the force is removed. If abnormally tense the resistance is increased and the globe feels like the cover of a book, like the surface of a table, or even like stone. The various degrees of increased tension are subject of judgment rather than measurement, although the signs $+T$, $+T_1$, $+T_2$, $+T_3$, have been suggested as indicative of various degrees. They are useful, but, of course, not exact, and when the letter T is prefixed by the sign — (minus) an abatement of tension is signified.

Symptoms of glaucoma accompanied by inflammation.—Glaucoma, accompanied by inflammatory action of various grades, presents the second type of the disease, and this is divisible into special forms according to the peculiarities of the inflammation—the inflammatory process may be acute, subacute, or chronic. When slow in its action the changes observed will be, a little vascular injection of the ciliary region of the sclera; a marked turgidity of the anterior ciliary veins, those which pierce the sclera near the insertion of the recti muscles; the aqueous humor will be turbid—consequently, both iris and pupil will lose their clearness; there may in some cases be blood in the anterior chamber—this space habitually becomes very shallow, the reason being that the iris and lens are pushed toward the cornea. The pupil, I have said, loses its clearness—it may give back a strong smoky reflex which, in some cases, so closely resembles senile cataract as to be considered a perfect specimen of this disease. It is true that cataract frequently follows in the train of glaucoma, but it is much more common to see in the pupil the appearance alluded to, which strongly simulates cataract, and to find, on examining by the mirror of the ophthalmoscope, that the lens is transparent.

It is important to remember this circumstance because a case is liable to be considered cataract, and in this way its loss of vision accounted for, while it may in truth be glaucoma. If merely cataract, the advice to wait until further developments occur may be sound; if

glaucoma, this advice may be fatal to sight. Sometimes the media become so far altered that the typical greenish hue is reflected from the pupil, but this appears only in the last stages of the disease.

As already said, cataract is one of the complications which may appear. The sclerotica often exhibits a glistening and striking whiteness, and this brings out in strong relief the swollen tortuous veins which course over its surface. The lens and iris are pushed forward to the cornea and thus in advanced cases the anterior chamber becomes excessively shallow. Very often at this period the surface of the cornea looks rough by changes in its epithelium. The hardness of the globe is often so great that it feels like touching a stone.

While these signs are developing the patient suffers more or less pain, and it may be very acute. It is in the eye and also shoots along the branches of the fifth nerve on the temple, forehead and vertex. Necessarily sight is badly damaged or totally lost.

Other signs noticed in the chronic forms of the disease are dilated and fixed pupil, loss of sensibility of the surface of the cornea, the iris becomes atrophied. In the deeper tissues of the eye the changes are as follows:

Symptoms within the eye.—The vitreous becomes hazy, diffiuent—the optic nerve excavated, the retinal veins flattened as they pass over the disc, they and the arteries pulsate spontaneously or upon slight pressure; sometimes the veins on the retina become varicose or even beaded as is shown in one of Liebreich's plates—there are sometimes extravasations on the retina. The appearance of the optic nerve is the characteristic sign. It is excavated as if driven back by a punch; in place of the normal elevation of its surface about one-half a millimeter above the adjacent retina, it is pressed down to one or one and one-half millimeters below this level. The nerve tissue is thus subjected to a mechanical paralysis and there necessarily ensues permanent change of structure, its fibers undergo atrophy. The means of recognizing this state of things are very perfect. In the first place the vessels are pushed out of their direct course against the sides of the pit, and as the perforation through the sclera is broader externally than internally, being a frustrum of a cone with its base backward; some of the vessels are for a short space concealed from view, and as they climb over the edge of the pit, they are not in direct continuation with their course upon the bottom of the excavation—hence the peculiar look shown in these plates (Jaeger). There is also a stasis of blood in the veins and a darker spot at the margin of the excavation; some vessels may appear to spring from the edge and not to have come up from below. The vessels which lie at the bottom are less distinct than those on the retina, because more out of focus. Examining by

the inverted image, if the objective lens be moved to and fro a little, of course the image moves with it, and the difference in level of the vessels will appear by the greater degree of excursion which the deeper vessels perform as compared with those in front of them. If the observer change his point of view to one side, a shadow will be thrown on one side of the nerve. If we examine the eye by the binocular ophthalmoscope the excavation of the nerve will declare itself with the utmost distinctness and to its full depth. The color of the nerve in chronic glaucoma arrests attention; it is too pale, the small vessels being atrophied, and is of a gray or dirty hue; the lamina cribrosa shows with great distinctness. This change in the nerve tissue becomes most evident upon examination by the upright image—to do this a concave lens must be put behind the mirror whose strength shall be in proportion to the depth of excavation. The number of this lens may be used to measure the depth of the excavation, as Mauthner has shown. When the bottom of the pit is brought to focus, the signs of degeneration of the nerve fibers become very apparent; they show a glistening opaque pearl gray look. Another result of the pressure is the greater breadth acquired by the so called scleral ring which surrounds the optic entrance.

With these signs of pressure it is easy to understand that the retina suffers severely and its tissue must undergo material degeneration.

The damage to sight in such cases is precisely analogous to the injury to the functions of the brain which ensues when it is subjected to pressure by tumors, depressed bone or clots.

The picture of disease will vary in individual cases, as the various features which I have enumerated are combined together, and as some or others become more conspicuous. For instance, in some cases the pupil is but little dilated; in others, it is very large, sometimes the engorgement of external vessels is very great, at other times moderate; sometimes the vitreous is quite clear, again very hazy; the lens may not be opaque. The loss of sight will sometimes be complete and absolute; sometimes there may remain the ability to see large objects, or even large print. Such being the symptoms of sub-acute or chronic inflammatory glaucoma, let us briefly consider the signs of acute glaucoma.

Symptoms of Acute Glaucoma.—These are very striking, and will always arrest attention. There is great swelling of the lids, injection of the eye-ball, abundant sub-conjunctival edema, a copious flow of watery fluid from the lids, the anterior chamber shallow, the aqueous muddy, the pupil dilated, and the media so cloudy that the fundus can scarcely be seen; tension of the globe felt to be extreme when the finger, pushing through the œdematous cushion of the lids,

reaches the globe; sight almost extinguished; pain intense, often agonizing. Such is the startling picture. It has developed rapidly; but, on inquiry, the person will be found to have had glaucomatous indications before. This state of things might be confounded with an attack of purulent conjunctivitis, but is easily distinguished by the absence of purulent secretion, by the tension of the globe, by the great loss of sight without ulceration of the cornea, and by the violent suffering. Such an inflammation was formerly called arthritic ophthalmia. An attack like this may abate after a time, and permit recovery of some vision, but settle down into the appearances of chronic glaucoma. It may also irrecoverably destroy sight and leave the eye-ball permanently painful.

Prognosis.—In both simple glaucoma and the inflammatory types of glaucoma, the prognosis is, that the disease will continue its progress, and sight ultimately be lost. Attacks of acute inflammation are to be apprehended, and these may suddenly destroy sight, or give place to the chronic state, with a material loss of visual power.

Etiology.—The etiology of the disease has excited much attention, and there is hope we may ere long comprehend it. The striking feature is increased intra-ocular pressure — and to produce this result, manifestly two elements must co-exist, viz., sufficient resistance and stiffness in the sclera, and increase in its fluid contents. Cusco and Adamieuk and Stellwag have called attention to the changes which occur in the sclera. It may undergo fatty degeneration, analogous to atheroma of the arteries; it certainly becomes more rigid, especially in its posterior segment. The sclera, in early life and in the normal state, although not strictly elastic, is flexible. The posterior ciliary veins which carry off the blood from the choroid pass through the tunic obliquely, and if this have become very rigid, the ready efflux of blood is liable to be hindered and a stagnation to take place in the choroid. It has been proven by experiment on animals, that if the posterior ciliary veins be tied, the tension of the globe becomes greatly increased, a result which we should naturally expect. But it is very remarkable how the circulation in the eye continues uniform, notwithstanding the vessels in the neck may be obstructed.

Another theory has been put forth to account for increase of intra-ocular tension, namely, some irritation of the nerves which preside over secretion. Donders at first made this suggestion, and it has received strong confirmation by late physiological experiments by Grünhagen and Hippel. It is shown that irritation of the third nerve and of the sympathetic nerves produce little or no augmentation of tension, while, if the fifth or trigeminus nerve be irritated a hypersecretion ensues which carries up the tension of the eye far

beyond any other cause—much farther than is produced by tying the abdominal aorta.

While the facts narrated do not fully explain the causation of glaucoma, they are suggestive, and give us hints for future observation.

Treatment.—Treatment is the next topic. But one method has any value, namely, the performance of an operation—and this for all the forms of the disease. The design of the operation is to procure a permanent diminution of tension and this iridectomy can do. The practical consideration in a given case is whether the eye is in a condition to permit iridectomy, and may yet be benefited by its performance. For example, in glaucoma simplex take the following case:

Mr. John H., 43, living in Indiana, a lawyer, being in New York, consulted me for deficiency of the sight of one eye. It had reached its present state so gradually that, though an intelligent man, he could relate very little about it. It did not exhibit any outward signs of serious change, but vision was reduced to $\frac{2}{3}$ instead of being $\frac{5}{6}$; the visual field was limited by an irregular, nearly horizontal, line, above which he was blind, and also blind on the nasal side; the globe was emphatically hard to the touch; the optic nerve was deeply excavated and the vessels displaced—the substance of the nerve betrayed signs of atrophy.

There was no doubt as to the propriety of operating on this eye—and it was done; the effect was a diminution of tension and arrest of the disease, proven by inspection four months after. In the other eye glaucoma had begun, but the tension of the globe was but little greater than normal, the nerve retained its proper pinkish hue, was but slightly pushed back and vision was $\frac{2}{3}$. It was deemed well not to operate on this eye as the patient's business required his attention. It was found after four months not to be perceptibly changed and he was sent home to return after another period of four months in the expectation of then submitting to the operation.

In this case the operation must be done to check the advancing mischief, but the rate of progress is so slow that something may be conceded to the patient's business engagements.

In some cases the propriety of iridectomy may be doubtful—that is when the disease has finished its work—when perception of light is gone, the tissues of the eye entirely degenerated. The only reason then for iridectomy is to relieve the pain consequent on the intra-ocular tension. But we are then not always successful in this result, because the eye is very liable to certain accidents in the operation. Take the case of which I show you this pathological specimen.

Mrs. M., 68, came to me eighteen months ago with glaucoma in the left eye and vision greatly impaired. She was urged to submit

to an operation, and the advice was enforced by her son-in-law, himself skillful in ophthalmology, but through timidity she refused. In November, 1868, I was called to see her suffering greatly in body and mind, because of pain in the eye which was first affected and whose sight was now destroyed, and because sight in the remaining eye was rapidly declining. She submitted under protest to an operation, and iridectomy was done with care upon both eyes,—in the one to restore sight, in the other to relieve pain. But loss of vitreous took place in the worse eye at the operation. For two weeks after, everything went well. Decided improvement took place in the sight of one eye and the other became quiet. But in the third week the bad eye became again inflamed and had to be extirpated. In the specimen you will be able to read what took place. At the operation, in spite of proper care, the thin hyaline burst and permitted prolapse of vitreous, the thin vessels also gave way, and you may see large clots between the choroid and the sclera. I may remark that the lens was cataractous when the operation was done. Because of these disturbances it was that the secondary inflammatory action took place, which nothing but enucleation could properly relieve. It would have been better for the patient to take out this eye at first, when the iridectomy was done on the other. I have seen a similar eye in which a similar accident occurred at the operation, go on for weeks giving the patient extreme pain and finally becoming reduced in size and softened, show nothing but an atrophied bulb. There are other accidents which may occur in such degenerated eye-balls. The iris may be so thin by atrophy as to be torn completely away from its whole circumference. An accident which is prone to happen in all chronic cases even those where sight may be restored is the production of cataract by the operator rupturing the capsule of the lens or the zonula of zinn. This is done either by undue pressure on the eye, by too sudden efflux of the aqueous humor, or by the entrance of the point of the knife into the lens.

I know no other cases than those above mentioned which are at the two extremities of the list, in which it is not imperative to tell the patient you must have or rather you may have an iridectomy done. I say *may* because so much certainty inheres in the operation if skillfully done and suitably early, that it is a priceless boon to the patient; medication is absolutely useless, rest is useless, paracentesis is to temporize, iridectomy is to arrest the disease and either to improve or perfectly restore or retain the sight. The amount of benefit to sight which may be expected depends on how long the disease has lasted and what sight remains. The earlier the case is taken in hand the more hopeful the issue. In old glaucoma simplex, the most to be hoped for is to keep intact the degree of sight remaining. In

cases with noticeable inflammatory symptoms, the effects of iridectomy are most satisfactory. A notable improvement of sight is the direct effect, and in many cases additional sight is gained during several months afterward.

Never do the achievements of modern ophthalmology shine with such brilliant lustre as when iridectomy is done for acute glaucoma. A violent inflammation is at once subdued, agonizing pain gives place to comfort, darkness almost perfect no longer oppresses the mind, as light dawns upon the eye and brightens ere long to perfect day.

To make iridectomy effectual it must be done in the edge of the sclera, at least half a line from the transparent edge of the cornea, and a piece must be removed one-fifth or one-sixth the circumference of the iris. In some cases a second operation becomes needful, because by the first the tension is not perfectly abated. It is often difficult to do the operation satisfactorily because the anterior chamber is shallow, the margin of the cornea hazy by arcus senilis and the iris reduced to a narrow band. In such cases if the usual lance-knife cannot be relied on, the operation may be done by the narrow knife used in modified linear extraction of cataract. (Graefes' operation.) I show these various instruments. The best place to make the iridectomy is upward, but this spot is the most difficult, and we may do it outward.

It is usually best to give an anæsthetic to get rid of the strain and spasm of the ocular muscles. The lids are separated by a speculum, the globe gently steadied by fixation forceps—the knife entered in the sclera as gently as possible—when the size of the cut is deemed sufficient the knife is slowly withdrawn; the curved iris forceps take hold of the membrane and drag it out, if it do not already prolapse into the wound, and the assistant cuts it off so as not to leave if possible a trace of it in the wound. The person who uses the scissors must do it skillfully, and if the assistant is not to be trusted the operator must do this himself, letting the assistant hold the fixation forceps if needful.

It is better to permit the blood to escape, so as not to fill the anterior chamber, by slightly keeping the wound open. Then put on a compress of cotton-batting or picked lint, and retain in place by a flannel bandage. This need not be removed for forty-eight hours, and may be changed once in two days—the whole time of its application will be eight to ten days, and the eye may then be well though not strong for twelve to twenty days.

The operation suggested by Mr. Hancock, which is a cut made in one of the meridians of the globe, through the limbus cornea and back, for one-quarter of an inch, into the sclera, may take the place of iridectomy in cases of acute glaucoma, but is not to be depended on as a

means of permanent relief in less urgent cases. It is useful to a practitioner to know that this simple procedure may conquer the acute attack and save the eye; his skill, perhaps, not being equal to the proper performance of iridectomy under circumstances in which it is often extremely difficult.

The question will be asked, how does iridectomy effect its purpose? I am not bound to answer how, when I can confidently affirm that it does accomplish a permanent abatement of tension. To this fact all modern operators subscribe. The following points have been suggested as giving a partial explanation of the effect: A portion of iris containing a certain number of blood-vessels which supply their quota of secretion is removed, a freer communication is opened between the vitreous and aqueous chambers, though the zonula of zinn is not ruptured; and what is, perhaps, the most essential, the cut is made at that part of the eye-ball which is most resisting. We see sometimes that when healing takes place, the wound does not unite by immediate apposition, but a considerable quantity of cicatricial tissue appears, which is more yielding than the sclera, and sometimes bulges out in a little prominence. This in fact occasionally becomes the cause of subsequent trouble.

It happens that the operation sometimes causes hemorrhage into the vitreous and into the nerve and retina, because, by the sudden relief of pressure, the thinned vessels give way. By this accident, the restoration of sight may be retarded, and it is desirable to avoid it if possible. Hence, the caution not to withdraw the knife suddenly from the eye, so as to allow a quick gush of aqueous humor.

I have perhaps already said too much. My aim has been so to depict the disease that it may be always recognized, or at least suspected; and, when recognized, to bring the mind of the practitioner to the instant decision: this case must not go any further. An operation, and nothing but an operation, can save the patient from blindness. Iridectomy shall be done.

To enforce this conclusion, I may adduce the following case: Mrs. C——, aged 72, widow, living in Schoharie county, N. Y., came to me, in September, 1868, blind in both eyes. Her husband I had successfully operated on for cataract eight years ago. The experience of her husband made Mrs. C—— alive to troubles of sight, and, as during a year she noticed such indications, she frequently complained of them, and wanted to come to New York for help. But, though she had some pain in her eyes, her trouble was looked upon as cataract, and as she retained some sight, it was deemed premature for her to seek further advice. In truth, when I saw her, the case, before the *eyes were touched*, looked extremely like senile cataract. The lenses were

partially opaque, but through them the ophthalmoscope enabled me dimly to discern the nerve. To the touch the eye-balls were hard as a stone. Sight was entirely abolished; there was no perception of light. I had no encouragement to give, but the old lady importuned me to do an operation. I consented to do it only because the total blindness had lasted but two weeks.

I did iridectomy upward in both eyes, without mishap and without an anæsthetic—she preferred not to take ether or chloroform and endured the operation with perfect fortitude. The usual dressing was applied, viz., a quantity of cotton over each eye and a flannel bandage. No unpleasant reaction took place. After nine days the eyes looked well, but though direct sun light was allowed to fall on them, the retinae made no response. Seeing her three months afterward, the tension of the globes was felt to be below the normal standard, but sight had not improved.

Had an instructed practitioner *put his fingers* on Mrs. C.'s eye-balls six months before she came to New York, he would at once have perceived the disease to be glaucoma; had an iridectomy then have been done, the issue would, in all human probability, have been, not blindness, but sight.

NEW YORK, 73 *Madison Avenue*.

